

**SECTION 38 - STORM DRAIN CONSTRUCTION
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SECTION 38 STORM DRAIN CONSTRUCTION

38-1 GENERAL

All sewer facilities constructed within the Sacramento Area Sewer District service area (<http://www.sacsewer.com/pdf/map-servicearea.pdf>) must be constructed in accordance with the Sacramento Area Sewer District Standards and Specifications available at <http://www.sacsewer.com/pdf/ord/2011-SASD-Standards-and-Specifications-v1.pdf>

Storm drain construction must conform to the details shown on the Plans and these Specifications. The Contractor must furnish and install pipe of the materials shown or specified in the Contract. Where alternate pipe materials are listed in the Bid, the Contractor must bid only one of the alternates shown. Substitution of alternate pipe material after bid is not permitted.

38-2 MATERIALS

Storm drain pipe must be of the type, class and size as shown or specified in the Contract, and must conform to the requirements of Section 50, "Construction Materials", of these Specifications for each type and class of pipe.

38-3 EXCAVATION AND BEDDING

Trench excavation and bedding for storm drain pipe construction must conform to Section 19, "Trench Excavation, Bedding and Backfill", of these Specifications.

The Contractor must expose the end of existing pipe to be extended for verification of alignment and elevation by the Agency prior to trenching for new pipe.

38-4 LAYING PIPE

38-4.01 Placement

Pipe laying can proceed after the trench has been excavated to the proper depth, foundation soils are found to be firm and non-yielding, and bedding has been placed and compacted to a non-yielding condition. Pipe laying must proceed upgrade with the bell end of the pipe placed upstream. Each section of pipe must be laid to plan line and grade, with uniform bearing under the full length of the barrel of the pipe. Suitable excavation must be made to receive the bell, which must not bear on the subgrade or bedding. Any pipe that is not in true alignment or shows any undue settlement after laying must be taken up and re-laid at the Contractor's expense. Pipe sections must be laid and jointed so the offset of the inside of the pipe at any joint is held to a minimum at the invert. The maximum allowable offset is as follows:

Pipe Diameter	Allowable Offset Joint
Less than 12 inches	3/8 inch
12 inch to 18 inch	1/2 inch
21 inch to 42 inch	5/8 inch

For joints that are polyurethane compression type, the mating surfaces must be clean and lubricated with a lubricant recommended by the pipe manufacturer. The pipe must be joined spigot into socket. For joints that are shielded rubber coupling the surface of the rubber sleeve must be thoroughly wetted with a silicone base lubricant as recommended by the manufacturer. Joints installed must have compression bands torqued to 70 inch-pounds minimum and must provide uniform tension.

The interior of the pipe must be cleared of all dirt and debris as the work progresses. Pipe must not be laid when the condition of the trench or the weather is unsuitable in the opinion of the Agency. Dewatering of the trench must be maintained as described in Section 10-5, “Control of Water in the Work”, of these Specifications. All open ends of pipe and fittings must be closed whenever the work is discontinued. For remedial maintenance or improvement projects in established areas, the Contractor must coordinate the work so that storm drain systems are fully operational at the end of each work day. No runoff is allowed to flow uncontained through any trenches or excavations.

Circular reinforced concrete pipe with elliptical reinforcement must be placed with the minor axis of the reinforcement in a vertical position.

38-4.02 Lines and Grades

All pipe must be laid in strict conformity to the prescribed line and grade with grade bars set and each pipe length checked to the top grade line. Three consecutive points on the same grade of slope must be used at all times to detect any variation from a straight grade. In case any discrepancy exists, the work must be stopped and the discrepancy immediately reported to the Agency. In addition, when requested by the Agency, a string line must be used in the bottom of the trench to insure a straight grade and alignment of the pipe.

The Contractor may use a laser beam system for grade and alignment control. The laser beam must have a minimum accuracy of ± 0.01 foot per 100 feet on line, a minimum visible range of 1000 feet, and must comply with OSHA requirements. The laser system must have good visibility when used with suitable target material. The laser system must be of the self-leveling type so that the laser beam is automatically compensated for small grade disturbances. The laser system must also have an early warning system that warns when the laser is off grade.

38-4.03 NOT USED

38-4.04 Grade Tolerance – Storm Drain

Grade tolerance of the flow line of storm drain pipe must not exceed ± 0.10 feet. The total variation (plus or minus) from design grade must not exceed the following for the stated pipe size:

1. Pipe 21-inch or smaller – 1 inch in 25 feet
2. Pipe 24 through 36 inches - 1.5 inches in 25 feet
3. Pipe 42 inches or larger – 2 inches in 25 feet

38-4.05 Existing Utilities and Facilities

Mortar or brick plugs must be installed in existing manholes as directed by the Agency in order to prevent surface water, ground water, and debris from entering existing storm drain systems during construction. Inflatable plugs are not permitted. Existing storm drain services must not be interrupted. Plugs must be removed upon completion of testing per Section 38-10, “Testing of Pipe”, of these Specifications.

The Contractor is responsible for avoiding and protecting all utility, service, or other conflicting lines that are not in direct physical conflict with the facility under construction. The Contractor may arrange with the owner of the utility to temporarily disconnect house service lines or other facilities along the line of work for the Contractor’s convenience. The Contractor is responsible for all costs for disconnecting and restoring such utilities.

Utility or other lines that are in direct physical conflict with the structural section of the facility being constructed or appurtenant structures and that cannot be avoided by rerouting the facility being constructed, or for which relocation is not provided in the Plans and Specifications, will be relocated by the owner of the utility prior to or during construction in accordance with Section 42, “Relocation and Maintenance of Utility Facilities”, of these Specifications.

If the facility being constructed needs to be rerouted to avoid an existing utility or other obstruction and the rerouting is ordered by the Agency, compensation for the rerouted line will

be made at the unit price bid for the installation of the facility and no additional compensation will be made except as provided in Section 9, "Changes and Claims", of these Specifications.

When indicated on the Plans or directed by the Agency, storm drain pipes and structures must be abandoned in conformance with Section 15-1.04, "Abandonment of Pipes and Manholes", of these Specifications.

If existing facilities are damaged due to adjacent construction the Agency or Utility is responsible for notifying the affected homeowner and/or Agency. The Agency or Utility causing the damage is responsible for replacement or repair of the pipeline and any damage resulting due to their actions.

38-4.06 NOT USED

38-5 NOT USED

38-6 STORM DRAIN INLET LATERALS

Unless otherwise indicated on the Plans or in the Special Provisions, storm drain inlet laterals must be a minimum of 12 inches in diameter. Unless otherwise indicated in the Contract, materials for inlet laterals must conform to requirements of Section 50, "Construction Materials", of these Specifications for each type and class of pipe.

Connections of laterals to manholes and inlets must be water and soil tight, and must conform to Section 39, "Manholes", and Section 27-13, "Drop Inlets and Catch Basins", of these Specifications.

All inlet laterals must be inspected by television inspection per Section 38-10.04, "Television Inspection (TVI)", in this Section of these Specifications.

38-7 PIPE JOINTS

Joints in pipe must conform to the requirements of Section 50, "Construction Materials", of these Specifications and the manufacturer's recommendations for the type of pipe being installed.

38-8 PROTECTIVE COVERING

38-8.01 NOT USED

38-8.02 Storm Drain Pipe

Unless otherwise shown in the Contract, storm drain pipe laid in trenches at such an elevation that the top of the pipe bell has less than the minimum cover indicated in Table 38-1 must be protected with a concrete cap, as shown on Standard Drawing 9-1, "Storm Drain Pipe Bedding and Initial Backfill". Unless otherwise specified in the Contract, the concrete used in making the cap must be Class "B" concrete conforming to Section 50-5, "Portland Cement Concrete", of these Specifications.

Table 38-1 Minimum Pipe Cover Requirements	
Pipe Material Type and Location	Minimum Cover Requirement
Corrugated Metal	Span/8 but not less than 12
Spiral Rib - Steel	Span/3 but not less than 12 inches
Spiral Rib - Aluminum with spans less than or equal to 72"	Span/2 but not less than 12 inches
Spiral Rib - Aluminum with spans greater than 72"	Span/3 but not less than 30 inches
Reinforced Concrete in unpaved areas and under flexible pavements	1/8 the diameter or rise (the greater of) but not less than 12 inches
Reinforced Concrete under rigid pavements	A 9-inch space between top of pipe and bottom of slab consisting of compacted granular fill must be maintained at a minimum.
Cast-in-Place-Concrete-Pipes in paved areas	The Structural Section plus 24 inches
Cast-in-Place-Concrete-Pipes in unpaved areas	Twenty-four inches (24")
Polyvinyl Chloride - D2241, D3034, F679, F789, F949, F1803,	Twenty-four inches (24")
Polyvinyl Chloride - C900, C905, C909	Twelve inches (12")
Polypropylene – F2736 & F2764	Twenty-four inches (24")

- Note: 1. All depths shown are for a minimum trench width per Standard Drawing 9-1.
 2. Cover for paved areas is defined as bottom of asphalt to the top of pipe.
 3. Metal/steel/aluminum pipe may not be used for mainline drainage facilities.

38-9 BACKFILLING PIPE TRENCHES

Backfill of all storm drain pipes must conform to the requirements in Section 19, "Trench Excavation, Bedding and Backfill", of these Specifications.

38-10 TESTING OF PIPE

Unless otherwise specified in the Contract, after laying, backfilling, and compacting pipe, and before placing the roadway aggregate base, the Contractor must clean the pipe system, test for obstructions and leakage, and perform the television inspection (TVI). The Agency might require pipes to be re-tested prior to the completion of the one-year warranty. The Contractor is responsible for the costs associated with this re-testing.

38-10.01 Tests for Obstructions

Unless otherwise indicated in the Contract, balling and flushing or other approved methods for cleaning storm drains is not required unless visual inspection by television or lamping indicates obstructions in the line.

38-10.02 Tests for Leakage

All leakage tests must be completed and approved at finished subgrade and prior to placing the aggregate base. The Contractor is responsible for conducting all leakage tests. The Contractor is responsible for providing all equipment, materials, and labor for performing and making measurements of the leakage tests. The Agency must witness all leakage tests and verify the accuracy and acceptability of the equipment utilized.

When leakage or infiltration exceeds the amount allowed by these Specifications, the Contractor must, at its own expense, determine the source, or sources, of leakage and repair or replace all defective materials and workmanship to the satisfaction of the Agency. The extent and type of repair that will be allowed, as well as results, is subject to the approval of the Agency. The completed pipe installation must then be retested and is required to meet the

requirements of this Section. Any individually detectable leaks must be repaired, regardless of the results of the tests.

The Contractor must test all sections of storm drain pipes for leakage by either air or hydrostatic testing. It is the intent of the leakage testing to test every installed pipe and pipe joint. If groundwater is present but the groundwater elevation is unknown, refer to Section 38-10.02.D(6) to determine necessary groundwater adjustment parameters for the leakage testing. If, in the opinion of the Agency, excessive groundwater is present, the water infiltration test must be used as specified in Section 38-10.02.E(2).

Leakage testing for pipes with a diameter greater than 42 inches must be specified in the Contract and approved by the Agency.

38-10.02.A NOT USED

38-10.02.B NOT USED

38-10.02.C NOT USED

38-10.02.D Air Test for Leakage - Storm Drain

The installer may use this test as a presumptive test to determine the condition of the line prior to backfilling, however, only lines tested after backfilling to final grade will be considered for acceptance.

The Contractor must furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. Sealant must not be used in any newly installed storm drain without the prior approval of the Agency. Proper structural repair work will be required by the Agency.

The Agency will witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized.

38-10.02.D.(1) Plug Restraint

Plug restraints must be provided to prevent blowouts of the plug. Sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be very dangerous. Every plug must be positively braced against the manhole walls and that no one be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line

38-10.02.D.(2) Relief Valve

All pressurizing equipment used for low-pressure air testing must include a regulator or relief valve set no higher than 9 psig to avoid over-pressurizing and displacing temporary or permanent plugs. The pressure in the test section must be continuously monitored to make certain that it does not at any time exceed 9 psig. (Note: It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization.)

38-10.02.D.(3) Equipment

38-10.02.D.(3)(a) Plug Design

Either mechanical or pneumatic plugs may be used. The Contractor must internally restrain or externally brace the plugs to the manhole wall throughout the test. Prior to any air pressure testing, all pipe plugs must be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure must be released, the leaks eliminated, and the test procedure started over again.

38-10.02.D.(3)(b) Singular Control Panel

To facilitate test verification by the Agency, all air used must pass through a single, above ground control panel.

38-10.02.D.(3)(c) Equipment Controls

The above ground air control equipment must include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge and a continuous monitoring pressure gauge having a pressure range from 0 to 15 psi. The continuous monitoring gauge must be at least 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of ± 0.04 psi.

38-10.02.D.(3)(d) Separate Hoses

Two separate hoses must be used: one to connect the control panel to the sealed line for introducing low-pressure air, and a separate hose connection for constant monitoring of air pressure build-up in the line.

38-10.02.D.(3)(e) Pneumatic Plugs

If pneumatic plugs are used, a separate hose is required to inflate the pneumatic plugs from the above ground control panel.

38-10.02.D.(3)(f) Air Compressor Capacity

To provide satisfactory test results, the air compressor capacity must be capable of pressurizing the test section in the required time, or less, as determined in Section 38-10.02.A.(3)(e). The compressor capacity required to accomplish the pressurization is equal to the rate necessary to fill the test section to the desired pressure plus the allowable air loss rate:

$$C = 0.17D^2L / T + Q$$

Where:

C = compressor capacity, ft³/min,
 T = required test time, or less, min,
 D = pipe internal diameter, ft,
 L = length of test section, ft, and
 Q = allowable air loss rate, ft³/min

38-10.02.D.(4) Pipe Preparation**38-10.02.D.(4)(a) Laterals, Stubs and Fittings**

All laterals, stubs and fittings into the storm drain test section must be properly capped or plugged to prevent air loss that could cause an erroneous air test result. Restrain gasketed caps, plugs or short pipe lengths with bracing stakes, clamps and tie-rods, thrust blocks or wire harnesses over the pipe bells.

38-10.02.D.(4)(b) Pipe Wetting

If porous pipe materials are used, the pipe walls must be wetted to temporarily reduce the porosity of the material.

38-10.02.D.(5) Test Procedure**38-10.02.D.(5)(a) Plug Installation and Testing**

After a manhole-to-manhole reach of pipe has been backfilled to final grade and prepared for testing, plugs must be placed in the line at each manhole and secured.

All plugs must be tested for leakage before use. Plug the upstream end of the line first to prevent any upstream water from collecting in the test line.

When plugs are being placed, the pipe adjacent to the manhole must be visually inspected for evidence of shear in the pipe due to differential settlement between the pipe and the manhole. The plug must be placed in the connected pipes outside of the manhole base and beyond the resilient connector. A probable point of leakage is at the junction of the manhole and the pipe; this junction will be tested in the manhole leakage testing in accordance with Section 39-4.02 of these Specifications.

Install and brace plugs to prevent blowouts. The amount of back pressure on the plug must

be calculated to be certain the plug being used is designed to withstand this pressure. A pressure gauge and regulator must always be used when inflating a plug. Under-inflated plugs will not be able to withstand the required back pressure.

38-10.02.D.(5)(b) Pipe Pressurization

Low pressure air must be slowly introduced into the sealed line. The internal air pressure must not exceed 5 psi for areas without groundwater located above the crown of the pipe. In areas with groundwater, the internal air pressure must be increased in accordance with Section 38-10.02D(6), "Determination of Ground Water Elevation and Air Pressure Adjustment", of these Specifications.

38-10.02.D.(5)(c) Pressure Stabilization

The air supply may be throttled to maintain internal pressure until the temperature stabilizes.

38-10.02.D.(5)(d) Timing Pressure Loss

When temperatures have been equalized and the pressure stabilized, the air hose from the control panel to the air supply must be shut off or disconnected. The continuous monitoring pressure gauge must be observed while the pressure is decreased to at least 3.5 psig greater than the average back pressure of groundwater over the pipe. At a reading of between 3.5 and 4.0 psig greater than the average groundwater back pressure, timing must commence with a stopwatch or other timing device.

38-10.02.D.(5)(e) Test Time

Table 38-2 shows the required test time, T , in minutes per 100 feet of pipe for each nominal pipe size. The criteria in Table 38-2 were calculated using the following formula:

Minimum test time (T) at a given allowable air loss (Q):

$$T = K \times D^2 L / Q$$

Where:

D = nominal size, in. (mm),

K = 0.370×10^{-3} for inch-pound units,

K = 0.564×10^{-7} for S.I. units,

L = length of line of one pipe size, ft (m)

Q = air loss, ft³/min (m³/min), and

T = time for pressure to drop 1.0 psi (7 kPa), min/100'

**TABLE 38-2
MINIMUM TEST TIME AND AIR COMPRESSOR CAPACITY FOR AIR LEAKAGE TEST**

Nominal Pipe Size, D in. (mm)	Minimum Test Time, T (Min:sec/100 ft)	Allowable Air Loss, Q (ft ³ /min)	Minimum Air Compressor Capacity (ft ³ /min)
4 (100)	0:18	2.0	8.4
6 (150)	0:42	2.0	8.4
8 (205)	1:12	2.0	8.4
10 (255)	1:30	2.5	10.5
12 (305)	1:48	3.0	12.6
15 (380)	2:06	4.0	16.8
18 (455)	2:24	5.0	21.0
21 (535)	3:00	5.5	23.0
24 (610)	3:36	6.0	25.1
27 (685)	4:12	6.5	27.2
30 (760)	4:48	7.0	29.3
33 (840)	5:24	7.5	31.4
36 (915)	6:00	8.0	33.5
39 (990)	6:36	8.5	35.6
42 (1065)	7:18	9.0	37.7

38-10.02.D.(5)(f) Testing Pipes with or Lateral Connections

If lateral connections are included in the test section, the lengths of the service or lateral connections may be ignored when computing required test times, unless otherwise specified in the Contract or directed by the Agency.

If the test section includes more than one pipe size, determine the minimum test time for each size and add the test times to arrive at the total test time for the section.

38-10.02.D.(5)(g) Pipe Acceptance Criteria

If the test time shown in Table 38-2 elapses before the air pressure drops 1 psig, the section undergoing the test has passed the test. The test may be discontinued once the prescribed time has elapsed even though the 1 psig drop has not occurred.

38-10.02.D.(6) Determination Of Groundwater Elevation and Air Pressure Adjustment

38-10.02.D.(6)(a) Applicability

The requirements of this Section apply where groundwater is known to exist or is anticipated above the pipe to be tested.

38-10.02.D.(6)(b) Pipe Nipple Installation

During manhole installation, a 1/2-inch diameter threaded pipe nipple must be installed through the manhole wall directly on top of 1 of the pipes entering the manhole. The threaded end of the nipple can extend a maximum of 2 inches on the inside of the manhole. The total length of the nipple must exceed the manhole wall thickness by at least 4 inches. The pipe nipple must be non-corrosive and resistant to chemicals common in domestic sewage. A permanent, watertight seal must be provided around the pipe nipple at the manhole wall. The pipe nipple must be sealed with a threaded 1/2-inch cap. Not every manhole is required to have a pipe nipple. A few key manhole locations is sufficient to establish a groundwater profile for the

test area. The Agency will assist the Contractor in selecting appropriate manholes for pipe nipple installation.

38-10.02.D.(6)(c) Groundwater Elevation

Immediately before testing, the groundwater level must be determined by removing the threaded cap(s) from the nipple(s) nearest the section to be tested, blowing air through the pipe nipple(s) to remove any obstructions, and then connecting clear plastic tube(s) to the pipe nipple(s). Each plastic tube must be held vertically to allow groundwater to rise in it. After the water level in the tube has stopped rising, a measurement of the height in feet of water over the invert of the pipe must be taken. (See Figure 38A). If the section to be tested is not immediately adjacent to an installed pipe nipple, the groundwater height must be estimated based upon nearby height readings and the pipe's invert elevation.

38-10.02.E Hydrostatic Tests for Leakage

38-10.02.E.(1) Water Exfiltration Test

The Contractor, at his own expense, must provide the water used in testing. If, in the opinion of the Agency, excessive groundwater is encountered in the construction of the storm drain, the water exfiltration test for leakage must not be used and the water infiltration test for leakage per Section 38-10.02.E(2) of these Specifications must be used.

38-10.02.E.(1)(a) Test Procedure

A section of pipe must be prepared for testing by plugging the upper side of the downstream manhole and all openings in the upstream manhole except the downstream opening. Service to existing storm drain laterals must not be interrupted. Plugs must be installed and tested as required in Section 38-10.02.D, "Plug Restraint", of these Specifications. Where grades are slight, 2 or more sections between manholes may be tested at once. Where grades are steep and excessive heads would result by testing from one manhole to another, test tees, the same size as the main, must be installed at intermediate points so the maximum head on any section under test does not exceed 11.5 feet.

The sealed test section must be filled with water to the Water Test Elevation at the upstream end of the test section. If it is not possible to test the pipe to the Water Test Elevation, the system must be tested to the surface of the lowest manhole or inlet rim in the section tested. The water must be introduced into the test section in advance of the test period to allow the pipe and joint material to become saturated with water. The water level must then be brought to the Water Test Elevation mark again. At the beginning of the test, the elevation of the water in the upper manhole must be carefully measured from a point on the manhole rim or test tee. After a measured period of time, the water elevation must be measured from the same point on the manhole rim or test tee and the loss of water during the test period calculated. If this calculation is difficult, enough water must be measured into the upper manhole to restore the water to the level existing at the beginning of the test, and the amount added taken as the total leakage.

38-10.02.E.(1)(b) Water Test Elevation

The Water Test Elevation for storm drain pipe must be 11.5 feet of head or 11.5 feet above the existing ground water elevation, whichever is greater.

38-10.02.E.(1)(c) Pipeline Acceptance Criteria

The allowable exfiltration rate for any length of the storm drain pipe between manholes must be measured and cannot exceed 500 gallons per inch of internal pipe diameter per mile of pipe per day.

38-10.02.E.(2) Water Infiltration Test

38-10.02.E.(2)(a) Test Procedure

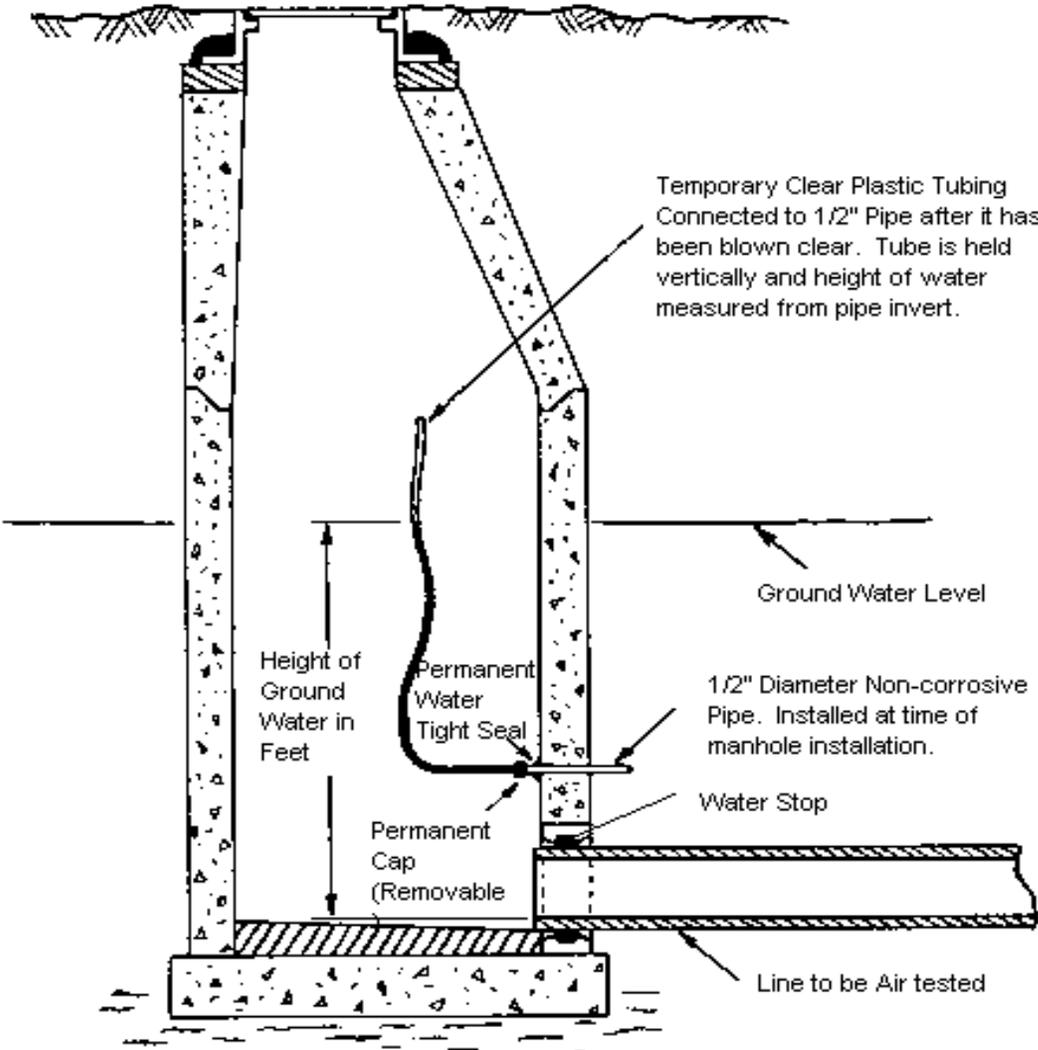
The end of the pipe at the upper structure must be closed sufficiently to prevent the entrance of water, and pumping of groundwater must be discontinued for at least 3 Calendar Days, after which the section must be tested for infiltration.

The infiltration rate for the test section must be measured by a weir or current meter placed in the appropriate manhole.

38-10.02.E.(2)(b) Pipeline Acceptance Criteria

The allowable infiltration rate for any length of the storm drain pipe between manholes must be measured and cannot exceed 500 gallons per inch of internal pipe diameter per mile of pipe per day.

FIGURE 38A
MANHOLE CROSS-SECTIONAL VIEW OF THE PROPER METHOD FOR DETERMINING
GROUND WATER HEIGHT



38-10.02.E.(2)(c) Air Pressure Adjustment

The air pressure correction, which must be added to the 3.5 psig normal test starting pressure, must be calculated as follows:

$$\text{(Average vertical height, in feet, of groundwater above the invert of the storm drain pipe to be tested)} \div 2.31$$

The result gives the air pressure correction in pounds per square inch, gauge, to be added. (For example, if the average vertical height of groundwater above the pipe invert is 2.8 feet, the additional air pressure required is 2.8 divided by 2.31, or 1.2 psig. This requires a minimum starting pressure of 3.5 psig plus 1.2 psig, or 4.7 psig.). The allowable pressure drop of 1.0 psig and the times in Table 38-2 are not affected and remain the same.

38-10.02.E.(2)(d) Maximum Test Pressure

The starting test pressure must not exceed 8.5 psig. If the average vertical height of groundwater above the pipe invert is more than 11.5 feet, the submerged section must be tested using 8.5 psig as the starting test pressure.

38-10.02.E.(2)(e) Re-sealing Of Pipe Nipples

After the groundwater height has been determined, each pipe nipple must be recapped and sealed to prevent any future infiltration.

38-10.03 Tests for Deflection**38-10.03.A NOT USED****38-10.03.B Storm Drain**

When indicated in the Contract, or when inferior products or construction methods are used or visual inspection by television or lamping indicates a potential for excessive deflection, a deflection test must be performed by the Contractor on PVC drain pipe. The test must be made after completion and acceptance of all backfill operations and prior to placement of the finished surface, if any. Deflection testing must be conducted no sooner than 30 Calendar Days after completion and acceptance of all backfill operations, unless otherwise approved by the Agency.

The deflection testing must be witnessed by the Inspector and must be conducted by the Contractor at the Contractor's expense. Unless otherwise shown on the Plans or in the Special Provisions, 100 percent of all mainline PVC drain pipe installed must be deflection tested for excessive vertical deflection using a pre-sized, rigid mandrel or "Go-No-Go" device approved by the Agency. The mandrel size must be clearly labeled and must be sized to provide a diameter of at least 92.5 percent of the "Base Internal Diameter" per ASTM D 3034 for PVC. Base inside diameters for larger diameters of PVC pipe can be found in ASTM F 679.

The Contractor must remove, replace, and retest any pipe section through which the mandrel is unable to pass. The use of any rerounding device or similar method to correct or reduce over deflection is not permitted. Re-tests for deflections must be made at the Contractor's expense.

38-10.04 Television Inspection (TVI)

This section documents the general procedures and codes required to perform a TVI. The need for a TVI is generated by both internal operations for the purposes of proactive maintenance activities or response to customer calls and by external projects existing or new systems. The processes may be slightly different depending on the need. For existing storm drain systems the TVI is used to identify the condition of the facilities and identify the location and extent of defects. The TVI provides information to allow for a determination of rehabilitation needs, to document pre-rehabilitation pipeline condition, and to document post-rehabilitation condition. The TVI is also used to schedule routine maintenance, thus avoiding emergency calls. For new storm drain systems, the TVI is used to document the initial condition of the pipe and

find defects caused by the installation of the pipelines.

For new facilities, a TVI must be performed to document that the new facilities were installed in accordance with the Contract and these Specifications. The TVI must be performed after all other testing has been completed to the satisfaction of the Agency, and before placement of AB road base or finished improvements within the storm drain easement.

A TVI must be conducted prior to all new pipeline acceptance. The TVI must document and verify the following:

- The condition of the pipeline.
- The location of laterals and taps.
- Line and grade.
- Cleanliness.

Prior to the TVI, the pipeline, including all appurtenances, must be sufficiently cleaned, as directed by the Agency, to allow for complete visual inspection of the pipe.

The TVI performed on all projects must be performed to these Specifications using the inspection (header) information described in this section and utilizing the National Association of Sewer Service Companies (NASSCO) code system within the Granite XP software, and be delivered on an external hard drive with a USB connection for the Agency to review for compliance with these Specifications. The hard drive will be returned to the TVI Contractor within 10 Working Days. Direct TVI submittals to:

County of Sacramento Department of Water Resources Drainage Maintenance
Engineering Section:
10151 Florin Road (MS 87-003)
Sacramento CA 95829
Phone: (916) 875-7159

The TVI must be performed after all required testing specified in the Contract is satisfactorily completed. The Contractor must perform separate TVIs on each lateral and each mainline.

The Agency will make a visual inspection of each facility after it has passed the testing requirements and is considered to be in its final condition. The inspection will determine the completeness of the facility; defects must be corrected to the satisfaction of the Agency before the TVI commencement.

38-10.04.A Safety

Safety and traffic control procedures must be maintained at all times in accordance with the requirements of Section 12, “Safety, Public Convenience, and Traffic Control”, of these Specifications, and any other applicable procedures or requirements.

The TVI must be conducted from above ground. Prior to opening a manhole cover or a confined space area, a gas monitor must be used to detect the oxygen level, presence of explosive or flammable gases, vapors, or mist in excess of 10 percent of the (LEL/LFL), and toxic gases in excess of the permissible exposure levels (Hydrogen Sulfide, Carbon Monoxide.)

Manhole entry, if required, must be conducted in strict accordance with permit required confined space entry regulations as specified in Section 12-1.05, “Confined Spaces”, of these Specifications.

38-10.04.B Agency-Approved TVI Contractor List

Before a TVI Contractor performs a TVI on an Agency storm drain system, the Contractor must demonstrate that their equipment, video quality, and data capture system is in compliance with the Specifications. When the TVI Contractor has met the Agency requirements, the TVI Contractor will be added to the “Approved TV Contractors” list. This section presents the requirements that a TVI Contractor must meet to be on this list. The TVI Contractor must be on the Agency’s “Approved TV Contractors” list prior to the submittal of any publically bid project by the Agency.

The “Approved TV Contractors” list will be updated annually in March. Recertification of each Contractor will be required every March.

38-10.04.B.(1) Sample Video and TVI Report Submittal

Prior to TVI Contractor approval by the Agency, the TVI Contractor must submit a sample video to the Agency for review in accordance with these Specifications. The sample video must represent the quality of video inspection and electronic data to be provided by the Contractor. Contractors must submit a complete sample inspection, similar in content to the project requirements, for the Agency to review prior to starting inspection work on the project.

38-10.04.B.(2) TVI Equipment Submittal

TVI equipment must include video cameras, a color monitor, digital recording equipment, sound, and voice recording capabilities, gauging tool, cables, power sources, and all equipment necessary to perform a TVI in accordance with the Contract and these Specifications. The Contractor must submit a complete list of equipment and operational information to be used for TVI’s, in accordance with Section 5-8 “Contractor’s Submittals”, of these Specifications.

38-10.04.B.(3) Camera

The camera must be a pan and tilt camera system, and must be specifically designed and constructed for storm drain environments. The camera must include a solid-state color video camera with a panning and rotational camera head, remote adjustable optical focus and automatic light compensation iris with remote override, camera controller with remote focus, iris and auto centering control and camera lighting system.

There must be no geometrical distortion of the image. The camera and monitor must be able to produce a minimum 460 lines of horizontal resolution and 400 lines of vertical resolution. Focal distance must be adjustable from a range of 1 inch to infinity. The camera must be mounted on skids or a tractor suitably sized for each pipe diameter to be inspected. The camera must move through the pipeline in a downstream direction whenever possible at a maximum uniform rate of 30 feet per minute. Maximum allowable error for all the footage counters cannot exceed 0.5 percent.

38-10.04.B.(4) Computer System

The Agency uses Granite XP software for capture of TVI data. Granite XP software must be used by all Contractors submitting TVIs for review and acceptance of work. Inspections must follow the Agency configuration standards and be exported according to specific directions provided by the Agency.

38-10.04.B.(5) Lighting

Illumination sensitivity must be 3 lux or less. During inspection, lighting intensity must be adjusted to minimize glare. Lighting and picture quality must be adjusted to provide a clear, in-focus picture of the entire periphery of the pipeline for all conditions encountered. Lighting must be adjusted according to the size of the pipe.

38-10.04.B.(6) Agency Facility Numbers

The Agency assigns facility numbers to each manhole and drain inlet. For new and replacement projects, facility numbers will not be assigned until the facilities are in the ground. The Contractor must submit 2 complete sets of approved plans, including the plan and profile sheets, reflecting the actual installation to the

County of Sacramento Department of Water Resources Drainage Maintenance Engineering Section:

10151 Florin Road (MS 87-003)

Sacramento CA 95829

Phone: (916) 875-7159.

Private systems will not be assigned Agency Facility Numbers or be reviewed for electronic compliance by the Agency.

38-10.04.C Scheduling a TVI for Construction

Prior to the TVI, the following items must be completed.

- Agency numbers assigned to manholes and drain inlets.
- Install backfill and compact:
 - underground facilities,
 - utility piping,
 - conduits, and
 - access structures.
- Acceptance of air or water leakage test.
- Cleaning of pipes.

The Contractor must coordinate with the Agency Inspector to be on site and witness the entire TVI. If an Agency inspector is not available, one of the two following situations will apply.

1. If the pipeline installation Contractor is doing the TVI an Inspector must be present. An alternate inspector may be requested from the Agency.
2. If the pipeline installation Contractor is not doing the TVI the TVI Contractor must verify on the TVI video the introduction of water into the pipe system and verify the target size with a tape measure.

The Project Inspector will fill out the top portion of the TVI Form and give to the TVI Contractor to be turned in with the TVI data. The Agency TVI Reviewer will complete the form after an office review of the pipe installation and distribute comments appropriately. If the TVI is witnessed, the inspector must fill out the TVI Form in full.

38-10.04.D Procedure

38-10.04.D.(1) Water Introduction – New Construction

Prior to performing the TVI on new construction, the Contractor must introduce enough water in the pipe segment(s) to fill all low sections and flow through the downstream structure. A 2-inch target must be used for storm drain pipelines, unless otherwise specified or directed by the Agency. If any section of the pipe segment appears to be dry, additional water must be introduced as described above. The Agency Inspector will verify the adequacy of water and target size before the TVI is performed. The TVI must begin within 30 minutes of introducing water into the pipe segment.

38-10.04.D.(2) Direction of TVI

Mainlines must be inspected from upstream structure to downstream structure whenever possible, except for drain inlets and stubs. Pipelines inspected against the flow direction must

be noted “Against the Flow” to indicate a reverse setup on the TVI Report.

38-10.04.D.(3) Pipelines (Mainlines and Laterals)

The Contractor must verify footage counter accuracy prior to the start of the TVI and calibrate the counter every 2 weeks during the TVI portion of the project. The recording must begin at the street surface. The camera set point (footage counter set point) must be from the center of the manhole to the focal point in the direction of camera travel. The footage counter must appear on the screen at all times. The camera must travel at a maximum speed of 30 feet per minute (fpm) with slowdowns at joints. The camera must stop and pan or tilt to observe and clearly identify the following.

- Centerline – Center of structure both at the upstream and downstream sections,
- Laterals that discharge into the structure,
- Start Line – The point of transition between structure and the pipe,
- Camera Set Point,
- Lateral taps,
- Joint separation (gap),
- Offset joints,
- Alignment problems and elbows,
- Cracked or damaged pipe including lined or point repaired pipe,
- Debris in the pipeline,
- Identifiable sags or high points in the pipeline,
- Root intrusion,
- Inflow or infiltration,
- Grease,
- Corrosion,
- Material Changes,
- Diameter Changes,
- End of Pipeline – End of the pipe at the structure wall.

38-10.04.E Electronic Data

38-10.04.E.(1) Header Information

This section covers the information and standard formats and codes required for completion of the TVI header in Granite XP, which is input prior to conducting the TVI. The header information contains the date and time of TVI and information about the inspection location, operator conducting the TVI, and pertinent data about the pipe being inspected. The header is completed in the field to provide as much information as possible about the inspection work. The table below includes a list of basic header information required for a TVI.

The following guidelines must be followed when completing the TVI header.

- Unless specifically required, do not enter units or abbreviations for measurements (e.g. in, “, feet, ft, ‘,).
- Use all capital letters.
- Enter all numeric entries to one decimal place, unless otherwise directed in these instructions.
- If the TVI extends through a structure and spans more than 1 pipe segment, a new header form must be completed at the start of each subsequent pipe segment.
- If a reverse set up is required because the TVI in the downstream direction could

not be completed due to an obstruction, a new header form must be completed at the start of the reverse set up TVI. If an inspection from the upstream structure was started and a video exists, a new header form must be completed at the start of the reverse set up TVI and the video should be related to the same inspection records as the initial video from the upstream structure.

Table 38-4 lists the required reporting header information for the TVI and provides an explanation of appropriate responses to each item.

Table 38-4 Granite XP Header Information

Information Label or Field Name	Appropriate Sample Responses	Description/Comments
Date Created	8/8/2010	Date TVI was performed
Start Date/Time	8/8/2010 18:34:24	Time of day using 24-hour clock
Status	PENDING	Status of the inspection progress
Surveyed Footage	152 FT	Length of the inspection
Direction	D – DOWNTSTREAM	Indicates whether TVI is in normal, With the Flow (upstream to downstream direction) (D) or Against the Flow (reverse set-up) (U).
Operator	DOEJ or Vendor ID	Vendor or Employee performing inspection
WO #	322527	The Agency work order number, if known
Review Priority	1	The Agency priority, if known
Facility Number	364-182-M24	ID of facility number
City	RANCHO CORDOVA	Jurisdiction in which site is located.
Street	123 MAIN ST	Street (or nearest street if pipe is in easement) and address number of upstream node of inspected segment
Pipe Size	8	Pipe diameter in inches
Pipe Material	RCP	Pipe material (see abbreviations)
Catalog #		Appropriate Number (Hanging Plan Number, Work Order)
Project Name/Work Order	PROJECT 2 SOUTH LAGUNA UNIT 2	Name of project for which TVI is being done or Agency Work Order Number
Comments/Summary		Indicate other pertinent information, such as if pipe was plugged during TVI, whether pipe was cleaned prior to, during, or after TVI, last PM date, reason if inspection was abandoned. Also indicate wheeled length if segment length was measured.

38-10.04.E.(2) Digital Data Format

The video files generated within Granite XP must use the Granite default format.

38-10.04.F Visual Data Procedure**38-10.04.F.(1) Pipelines (Mainlines and Laterals)**

Mainline and lateral inspections are performed from structure to structure. Each individual pipe segment requires a separate inspection record and video. Immediately before the insertion of the camera into the structure, the following information must be provided as text on the video recording. The text must be clearly displayed on a contrasting background (e.g. white text on dark background or black text on white background). The text must be displayed for approximately 15 seconds or for the duration of the Start-up Narration, whichever is longer.

If an inspection is being performed on consecutive pipe segments with the same set-up, this information must be provided at the start of each pipe segment.

- Upstream and downstream facility numbers (or “from” and “to”) facility numbers of inspected pipe segment.
- Direction of camera travel: The direction of camera travel must be in the direction of flow in the pipe unless there are access problems that require a reverse set-up, or the camera cannot pass through the pipe from end-to-end in the direction of flow. A reverse set-up must be performed against the flow if there is an upstream structure access problem or restricted mainline access, or because an obstruction prevents the camera passing. Reverse set-ups for convenience are not acceptable. All TVI observation locations are to be recorded based on the direction of camera travel.
- Purpose of the TVI.
- Location.
- Date and time of day.
- Project name or work order number.
- TVI company or Agency staff.
- Operator’s name.

During the TVI, the running screen must include the following information. The display of this information must in no way obscure the central focus of the pipe being inspected.

- Running footage (distance traveled): The “zero” point of the TVI is the centerline of the structure where the camera is inserted. The footage counter must be set accordingly by adding the footage from the centerline of the structure to the edge of the structure plus the camera length (or the camera length plus the camera focal length).
- Upstream and downstream facility numbers.

Defect codes must not be shown on screen text. The end point of the segment is the centerline of the structure at the opposite end of the pipe segment from the starting structure. The end point of the inspected pipe segment must be recorded for approximately 15 seconds.

If a TVI set-up passes through a structure not shown on the storm drain maps, a structure centerline observation code must be recorded at the footage location of the new structure. At the same footage location a structural UNK code must also be created to annotate an unknown structure has been found. A new TVI record must not be started.

38-10.04.F.(2) Interruption of Progress

If the camera becomes stuck or otherwise cannot progress, the cause of the interruption must be evaluated, reported, and, if possible, corrected. If the camera cannot pass, a reverse

set-up must be used if feasible to complete the TVI. If cleaning the pipe is required before the TVI can be resumed, recording of TVI observations must continue at 0.1 foot beyond the position where the TVI was interrupted. A comment regarding the cleaning procedures must be included in the data record.

38-10.04.F.(3) Defect Panning

When a defect or other feature is encountered in a pipe, it must be recorded at the footage indicated on the footage counter by using the Observation Codes contained in Granite XP under the NASSCO code system. Progress of the camera must be slowed and stopped for a minimum of 15 seconds or as needed so that the observation can be panned with the camera, the data recorded, narration made, and a still picture captured if required.

38-10.04.F.(4) Counter Calibration

The footage counter for the camera must be calibrated at least every 2 weeks during TVI operations. The footage counter must be accurate to 0.5 percent. The calibration is performed by checking the cable counter against a measured length of 400 feet. The date of last calibration must be verified by the Inspector before every TVI.

38-10.04.F.(5) Verification of Map Length

If the map length (as indicated by the written distance shown on storm drain plans) and the TVI field length for a pipe segment differ by more than 0.5 percent, the field length must be verified by measuring between the centerlines of the structures using a measuring tape or wheel. The measuring wheel must also be calibrated every 2 weeks along with the TV footage counter. In measuring the pipe length, common sense must be used to take into account the topography of the ground surface and the alignment of the storm drain.

38-10.04.F.(6) Lighting

Lighting in the pipe must adequately illuminate the pipe with a minimum amount of glare. Lighting must be adjusted to provide a clear picture of the entire periphery of the pipe for all conditions encountered. Illumination sensitivity must be 3 lux or less.

38-10.04.F.(7) Flow Level

The flow level requirements for TVI vary depending on the type of inspection being performed. Generally, the more pipe visible, the more data is obtained. Lower amounts of visible pipe wall may be allowed, depending on site conditions, with approval of the Agency.

For new construction, nearly 100 percent of the circumference of the pipe wall circumference must be visible. A small amount of water must be introduced for purposes of sag identification.

38-10.04.F.(8) Camera Travel Speed

The camera travel speed must be a uniform rate of no more than 30 fpm. The camera speed must be slower when recording features and defects.

38-10.04.F.(9) Clarity

All video and still picture images must be clear and sharp. The camera operator must adjust focus, iris, zoom, and lighting as needed to obtain a satisfactory image. The recorded image from the TVI camera must be free of fog or haze in the pipe. If the camera lens becomes obscured with condensation, grease, scum, or debris, the camera must be removed from the pipe, cleaned, and reinserted to continue inspecting the pipe. For increased clarity, the Contractor must also try adjusting the iris, focus and zoom of the camera.

38-10.04.G Pipeline Narration

The TVI video recordings are part of the Agency's permanent records and must not contain inappropriate language, idle chatter, background noise, and discussions between the operator

and other crew members. All video narration must be live by the TVI operator. All defect codes must be narrated. Digital voice narration is only allowed if specifically approved by the Agency.

38-10.04.G.(1) Pipelines (Mainlines and Laterals)

A voice narration must be included in the video recording. This narration must include the following information at the beginning of each pipe segment.

- Upstream and downstream facility numbers.
- Direction of camera travel.
- Type (mainline) and purpose of inspection.
- Location (address).
- Date.
- Work Order Number (if applicable) and project name.
- Pipe size.
- Pipe material.
- TVI company or Agency Staff Name.

All observations along the length of the pipe must also be narrated, with a description of the observation and clock position, if applicable. For example

- “Tap at 10 o’clock at 56 feet; factory tap”
- “Severe roots at 23 feet, all around crown of pipe”
- “Medium grease and scum at flow line starting at 45 feet”... “End grease at 85 feet”

At the conclusion of the inspection of a pipe segment, the operator must state the final TVI footage and indicate that the TVI of the pipe segment is complete. For example

- “TVI of storm drain mainline from manhole 364-182-M24 to manhole 364-182-M25 is complete at 222 feet” If the inspection had to be abandoned before reaching the ending structure, then a statement to this effect must be made as part of the ending narration with a reason given as to why the inspection could not be completed.

38-10.04.H Observation Codes

NASSCO code system will be used for recording observations of pipe features and defects identified during the TVI.

38-10.04.I Nonconforming TVI

If the quality of the video recording is not in compliance with these Standards and Specifications, the pipeline must be reinspected or revised at the Contractor’s expense. *All inspections that fail to meet these standards can and will be rejected.*

38-10.04.J Acceptance Criteria for New Construction

The following types of deficiencies must be corrected by the Contractor at no cost to the Agency:

- Joint separation equal to or greater than 1/2 inch.
- Offset mainline joints equal to or greater than one-half the pipe wall thickness.
- Joint deflection of more than 75 percent of manufacturer’s recommended maximum.
- Cracked or damaged pipe, including liner pipe.
- Debris in the pipeline.
- Identifiable sags or high points (i.e., out of tolerance grades per Sections 38-4.04).

- All necessary easements must be recorded prior to pipeline acceptance.
- Noncompliance with any other requirements of these Specifications or the Contract Documents.

The Contractor will be notified in writing of any deficiencies. The Contractor may request to review the video with the Agency. Deficiencies in electronic data must be corrected and resubmitted to the Agency within 10 Working Days, and must reflect current coding and labeling procedures as referenced in these Standards and Specifications.

Upon completion of all required corrective actions, the pipes must be cleaned as necessary and reinspected (TVI) in accordance with these Standards and Specifications and submitted within 5 Working Days after completion of the TVI. This process must be repeated until the Agency review of the final TVI Report indicates that the pipe installation, cleaning, and electronic data meet all requirements of the Contract Documents.

38-11 NOT USED

38-12 MEASUREMENT AND PAYMENT

The quantity of storm drain construction of the sizes, grades, and types of pipes listed in the Contract is the slope length designated by the Agency, measured along the centerline of the pipe from manhole to manhole, and includes the straight run of all wyes and tees where used. The length is measured from the inside face of the structures and does not include the inside diameter of manholes and other structures. The prices paid per linear foot for the sizes, grades, and types of pipes listed in the Contract include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in storm drain construction, complete in place, including furnishing pipe, excavation and backfill, removing obstructions, removing and replacing utilities, bedding, placing and jointing the pipe, testing pipe lines, connecting to existing manholes or pipes, as shown or specified in the Contract, in these Specifications, and as directed by the Agency. Full compensation for wye or tee fittings placed in a main storm drain in connection with storm drain services is included in the price paid per linear foot for the main storm drain pipe and no additional compensation will be paid.

The quantity of storm drain services of the sizes, grades, and types of pipes listed in the Contract will be measured by the unit constructed in place. The unit prices paid for the storm drain services of the respective sizes, grades, and types of pipes listed in the Contract include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in furnishing and placing all service pipe from the wye or the fitting in the main storm drain to the property line, complete in place, including furnishing and placing other necessary bends and stoppers to construct the service, as shown or specified in the Contract, as specified in these Specifications, and directed by the Agency.

The cost of each TVI and inspection is all-inclusive and is included in the price paid per linear foot of pipe, or as specified in the Contract Documents. Payment for TVI work that is not required as part of construction work for pipeline rehabilitation will be made on an actual inspected lineal footage basis per diameter of pipeline inspected and includes the cost of all items necessary to complete the TVI including bypass pumping or flow control that is required to perform the inspection.

No direct payment will be made for TVI services required as part of a construction work for pipeline rehabilitation. Payment for TVI is included in the Contract bid prices for the related rehabilitation items.